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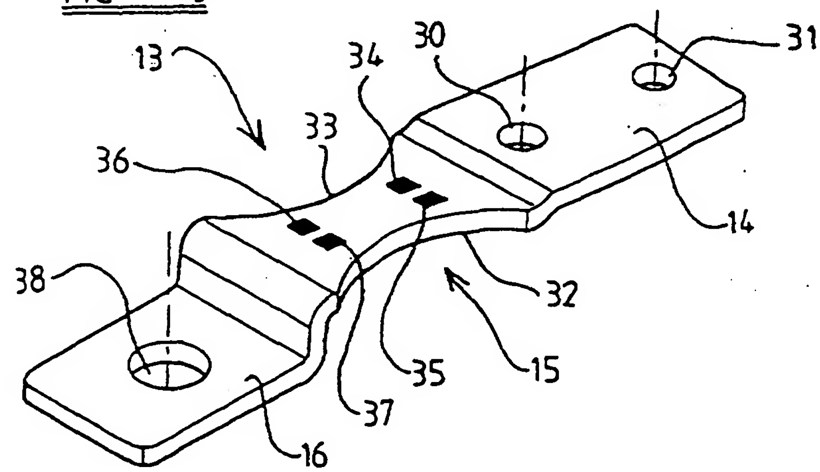
(54) Abstract Title
A sensor arrangement with a deformable region

(57) A sensor arrangement comprising a first and second portion, inbetween which lies a "waisted" (narrowed) deformable portion which has a sensor element thereon. The sensor element may be a load cell (preferably a piezo-electric sensor or a strain gauge sensor). The sensor arrangement may be incorporated in a vehicle seat with the sensor output being indicative of downward force or weight.

FIG 3



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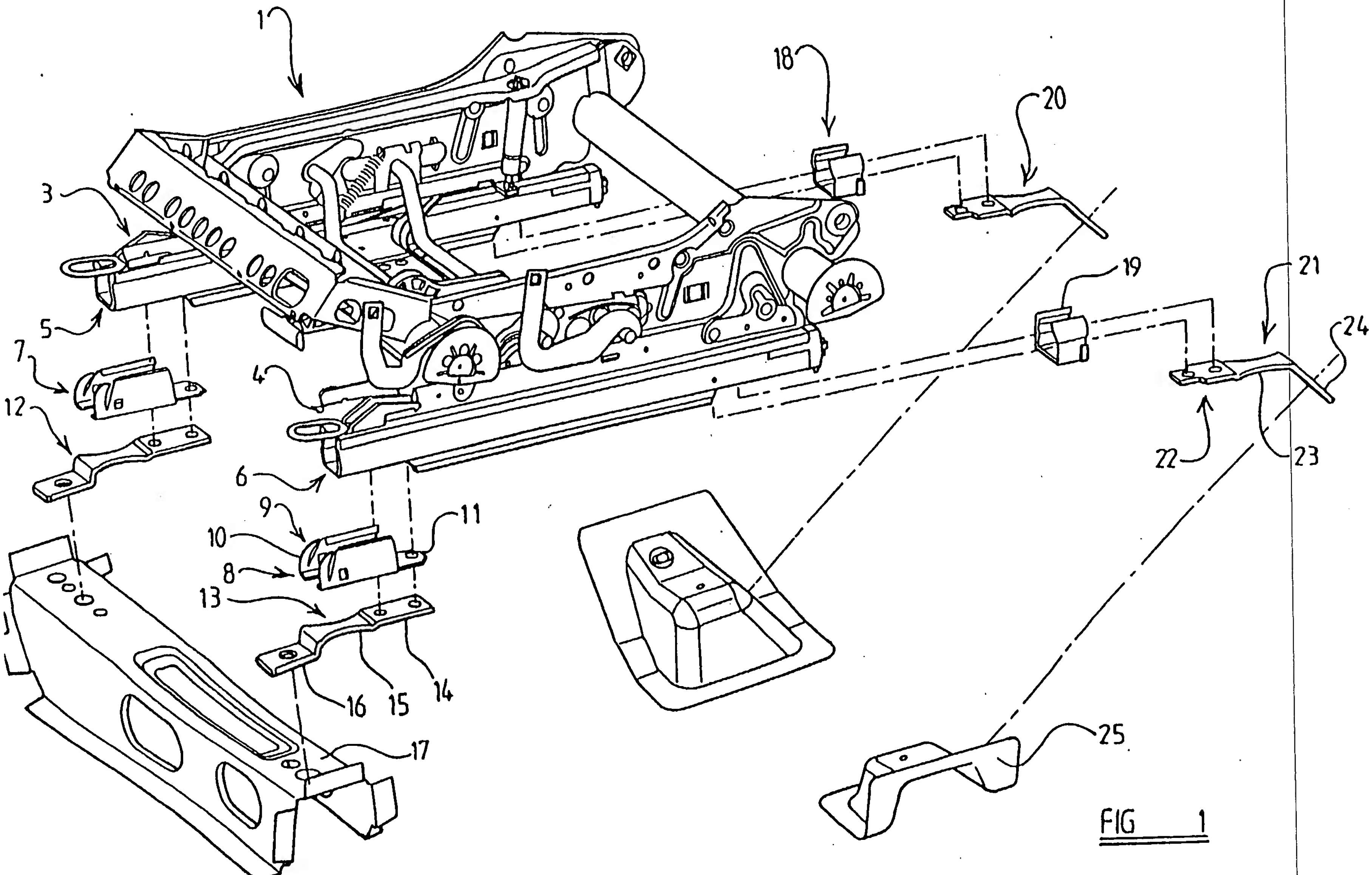


FIG 1

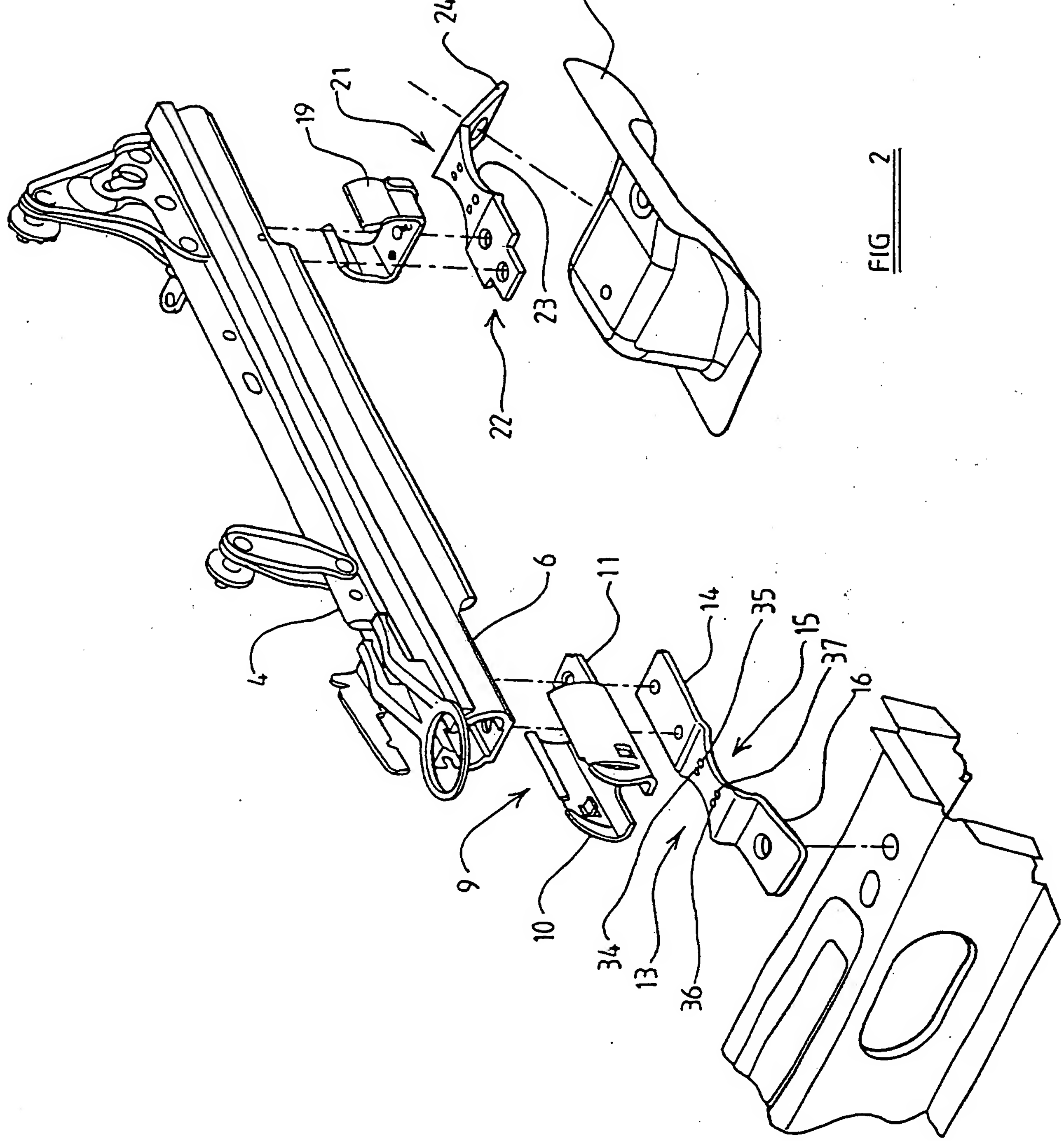
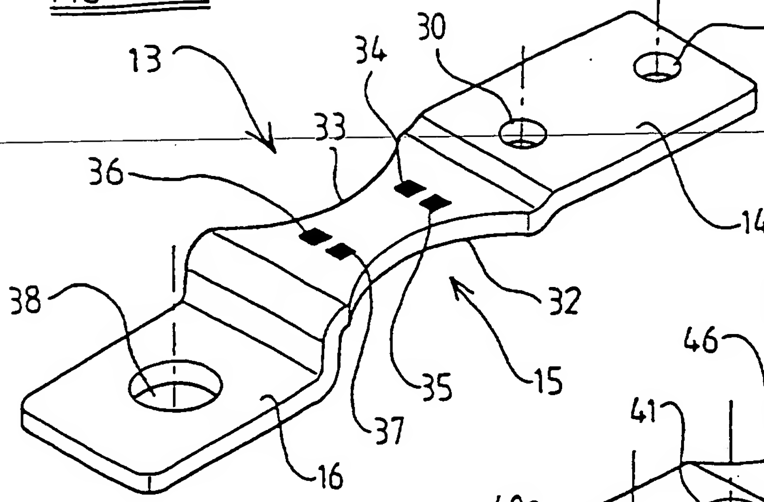


FIG 2

FIG 3



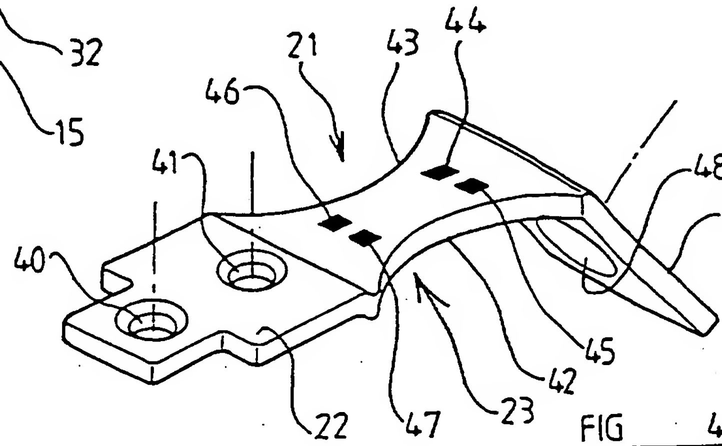
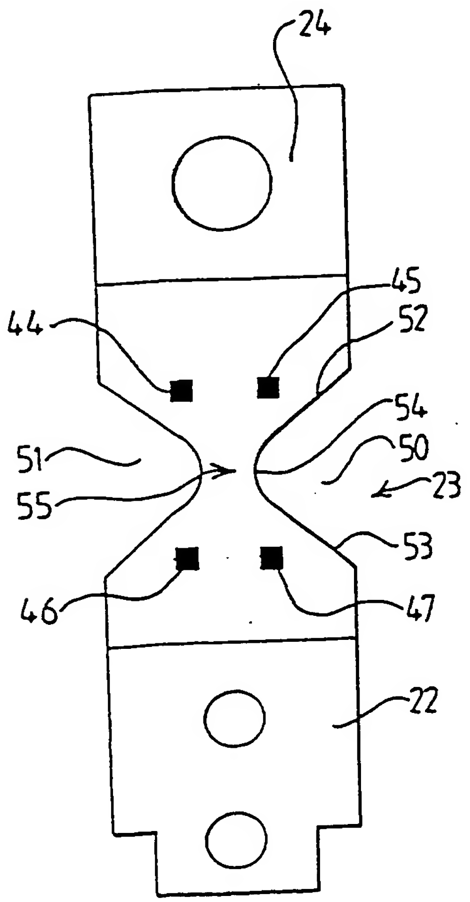
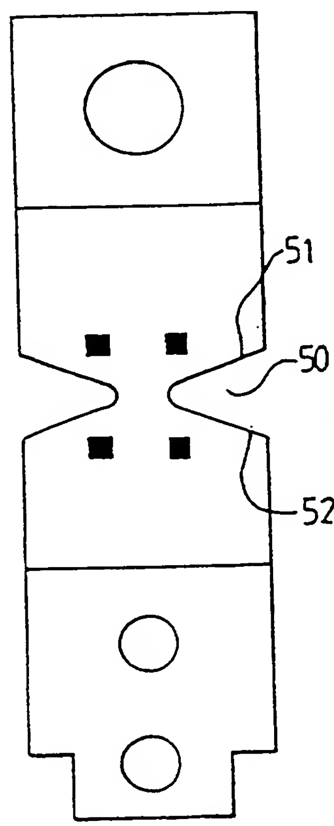


FIG 4





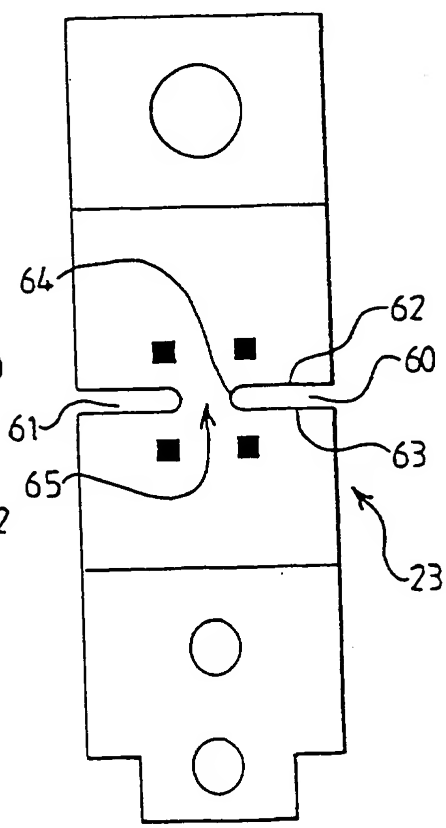


FIG 5

FIG 6

FIG 7

DESCRIPTION OF INVENTION

"IMPROVEMENTS IN OR RELATING TO A SENSOR ARRANGEMENT"

THE PRESENT INVENTION relates to a sensor arrangement, and more particularly relates to a sensor arrangement that may be utilised in a motor vehicle.

It has been proposed to provide, in a motor vehicle, an air-bag adapted to be inflated in the event that an accident should occur to provide protection for the driver or occupant of the vehicle. The air-bag is designed so that, when the air-bag is inflated, it occupies the space in front of the occupant of the vehicle. During deployment of the air-bag parts of the fabric from which the air-bag is made may move with a very high velocity.

It will be understood that if an air-bag is to be designed to fill, rapidly, the space in front of the occupant of a movable seat, a problem may be encountered. If the air-bag is designed only to fill the space that would be located in front of the occupant of the seat, if the seat were in its forward-most position, then the air-bag would not satisfactorily fill the space in front of the occupant of a seat when the seat is in the rearward-most position. However, if the air-bag were designed to fill the space in front of the occupant of the seat

when the seat is in the rearward-most position, then part of the fabric of the bag would, on inflation of the air-bag, impact with the occupant of the seat if the seat were in the forward-most position.

Consequently it has been proposed to provide air-bags which have an inflation characteristic which depends upon the position of the occupant of the seat, that is to say whether the occupant is in a forward position or is in a rearward position. In order to control the inflation of such an air-bag it is necessary to determine the position of the occupant of the seat.

It has been proposed to mount a vehicle seat on two parallel rails, with each end of each rail being connected to the vehicle by a unit adapted to generate a signal responsive to the downward force applied to the unit. A typical unit of this type comprises a cantilevered beam provided with at least one sensor element thereon adapted to provide an output signal in response to deformation of the beam. Such a cantilevered beam may be termed a "load cell".

By determining the downward force applied to the four units supporting the two parallel rails, it is possible to calculate the position of the occupant of the seat, relative to a forward/rearward axis of movement, and it may also be possible to determine the weight of the occupant of the seat.

It has been found, however, that difficulties arise when using an arrangement of this type, especially if the rails are not absolutely parallel. It is, of course, very difficult to ensure that the rails are, when mounted in a vehicle, absolutely parallel and, as a consequence, the rails may be considered to converge towards one end. As the seat is moved towards that end of the rails, because the parts of the seat that engage the rails are a fixed distance apart, a

lateral force will be applied to the rails. This lateral force is transferred to the units supporting the ends of the rails and, as a consequence, the cantilevered beam is distorted. This, unfortunately, introduces an error into the system, and consequently the system cannot be utilised reliably to determine the position of the occupant and/or the weight of the occupant.

The present invention seeks to provide an improved sensor arrangement.

According to this invention there is provided a sensor arrangement incorporated with a vehicle seat for sensing the position of the occupant of the vehicle seat, wherein the vehicle seat is provided with two carriages, each carriage being mounted for axial movement along a respective elongate rail to permit adjustment of the position of the seat, the rails being mounted in a motor vehicle in a substantially horizontal position, the rails converging so that the distance between the rails, at one end thereof, is less than the distance between the rails at the other end thereof, each end of each rail being mounted to a fixed part of the motor vehicle by means of a respective unit, each unit being adapted to generate a signal responsive to the downward force applied to the unit wherein each unit comprises a first region connected to the respective rail, and a second region connected to a fixed point on the motor vehicle, and an intermediate deformable region, the deformable region being of a "waisted" configuration and having one or more sensor elements thereon adapted to provide an output signal in response to deformation thereof.

The invention also relates to a sensor unit, said unit comprising a first portion by means of which the unit may be connected to one element, and a second portion by means of which the unit may be connected to a second element, and an intermediate deformable region, the deformable region being of

a "waisted" configuration, and carrying at least one sensor element responsive to deformation of the deformable region.

Preferably the deformable region is provided with two pairs of sensor elements thereof, each pair of sensor elements being located on a respective side of the narrowest part of the waisted deformable region.

In one embodiment each sensor is a piezo electric sensor, but alternatively each sensor is a strain gauge. In one embodiment the deformable region has two opposed concave arcuate side edges to provide the waisted configuration, but alternatively the deformable region has two inwardly directed substantially "V"-shaped recesses to provide said waisted configuration. In one embodiment the angle between the opposed sides of each "V"-recess is substantially 80°, but in an alternative embodiment the angle between the opposed sides of each "V" recess is approximately 40°.

In a further modified embodiment of the invention the deformable region is provided with opposed inwardly directed parallel-sided slots to provide said waisted configuration.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is an exploded view of the lower part of a vehicle seat and rails, by means of which the seat is connected to the structure of a vehicle,

FIGURE 2 is an exploded view showing one rail, and the components by means of which the rail is secured to the vehicle, and one carriage that forms part of the seat,

FIGURE 3 illustrates a load cell forming part of the means to mount the rail to the vehicle,

FIGURE 4 is an enlarged perspective view of another load cell forming part of the means to secure the rail to the vehicle,

FIGURE 5 is a perspective view of a blank used to make a load cell of the type shown in Figure 4,

FIGURE 6 is a view corresponding to Figure 5 showing an alternative form of blank, and

FIGURE 7 is a view corresponding to Figure 5 showing a further alternative form of blank.

Referring initially to Figure 1 of the accompanying drawings, a frame 1 is illustrated, the frame being adapted to form the lower part of the seat of a vehicle. Depending from the opposed sides of the frame 1 are two carriages 3,4, of substantially identical design. Each carriage is slidably mounted for axial movement along a respective horizontal rail 5,6. The forward end of each rail 5,6 is received within a respective shoe 7,8. The shoes 7,8, are of the same design, and each incorporate a portion 9 adapted to embrace the forward end of the rail, the portion 9 carrying two inwardly directed tabs 10 which effectively close the front end of the rail to prevent the carriage that is slidably mounted on the rail moving out of the forward end of

the rail. The shoes 7, 8, also incorporate a rearwardly extending lug 11. The base of the shoe and the lug 11 define two apertures which are co-aligned with two apertures (not shown) formed in the respective rail.

A load cell element 12, 13 is associated with each shoe 7,8. The load cell elements 12,13 are identical. The load cell element 13 comprises a first plate 14 having two apertures adapted to be co-aligned with the apertures formed in the base and the lug 11 on the shoe 8. A pair of bolts or the like may be passed through the co-aligned apertures formed in the plate 14, the lug 11 and the rail 6 in order to connect these three components together. The plate 14 is formed integrally with a deformable portion 15 of the load cell 13, which will be described in greater detail below. The deformable portion 15 is connected to a further cranked plate 16 defining an aperture therethrough. A bolt or the like may pass through the aperture in the cranked plate 16 in order to secure the load cell 13 to a transverse beam 17 forming part of the chassis of the vehicle.

At the rearward end of each rail, a respective shoe 18,19 is provided adapted to embrace the rearward end of the rail, and each shoe is provided with two apertures formed in the base thereof, the apertures being dimensioned to be co-aligned with two apertures formed in the base of the respective rail (not shown). The shoes 18,19 are of the same design.

Associated with each shoe 18,19 is a respective load cell element 20,21 of identical design.

The load cell element 21 comprises a first mounting plate 22 having two apertures therein adapted to be co-aligned with the apertures formed in the base of the shoe 19 so that fastening elements, such as bolts, may be passed through

the co-aligned apertures. The load cell element 21 incorporates a deformable portion 23 connected to the plate 22, there being a mounting plate 24 also connected to the deformable portion 23. The plate 24 is provided with an aperture adapted to receive the bolt to secure the load cell element 21 to a mounting lug 25 mounted on the chassis of the vehicle. The precise nature of the load cell element 21 will be described in greater detail below.

Each load cell element 12, 13, 20, 21, as will be described in greater detail below, is adapted to provide an output related to the downward force applied to the load cell element by the rail supported by the respective shoe.

The rails 5, 6 are mounted in position lying in a horizontal plane. Although the rails are mounted in position to be parallel, it is inevitable that the rails are not absolutely parallel, and thus the rails will converge slightly. For the purposes of explanation, it is assumed that in the described embodiment of the invention, the rails 5,6, converge slightly towards the rearward end of the vehicle. In other words, the distance between the shoes 7 and 8 is slightly greater than the distance between the shoes 18 and 19. Since the distance between the carriages 3,4, mounted on the frame 1 is constant, as the seat incorporating the frame 1 is moved, from a central position, rearwardly along the rails 5,6, the rearward-most ends of the rails will be forced laterally outwardly. This movement of the rails will tend to provide a counter-clockwise twisting motion or a lateral outward motion to the plate 22 of the load cell element 20 associated with the shoe 18, whilst also providing a clockwise twisting motion or a lateral outward motion to the plates 22 of the load cell element 21 associated with the shoe 19.

Similarly, as the carriages 3,4 carrying the frame 1 move forwardly along the rails 5,6 from a central position, a counter-clockwise rotation or a

lateral outward motion is applied to the plate 14 of the load cell element 12 associated with the shoe 7, whilst a clockwise rotation or a lateral outward motion is applied to the plate 14 of the load cell 13 associated with the shoe 8.

It will be clear that the rotations of the plates as described above are considered when viewing the plates from a position located to the front of the combination of the rails and the frame to support the vehicle seat.

The load cell elements 12,13, 20,21, as will become clear from the following description, are adapted so that even when subjected to "twist" or lateral outward motion as a consequence of the positioning of the frame 1 axially along the rails 5,6, they provide an output solely dependent upon the downward force applied to the load cell elements through the respective shoes. The signals from the load cell elements may thus be utilised to determine the weight and position of the occupant of a seat carried by the frame 1, even though the rails are not precisely parallel.

The load cell elements are consequently adapted to be insensitive to twisting of or lateral deformation of the deformable part of the load cell unit, but responsive to downward deflection of the deformable part of the load cell unit.

Figure 3 illustrates the load cell element 13. The load cell element 13, as mentioned above, includes a plate 14, provided with apertures 30,31, by means of which the plate is connected to the shoe 8 and the rail 6. The plate 14 merges with a deformable portion 15 of the load cell element. The deformable portion is of generally rectangular form, but has a "waisted" configuration, so that opposed sides 32,33 of the deformable portion 15 are of curved concave form. Thus the central part of the deformable portion has a width which is less

than the width of each end part of the deformable portion. Mounted on the deformable portion 15 are two pairs of sensor elements 34,35,36,37. The sensor elements are located adjacent each other, spaced slightly from the narrowest part of the "waist" of the deformable portion 15. The deformable portion 15 is connected to the cranked mounting plate 16, as described above, which is provided with an aperture 38.

The sensor elements may be piezo electric sensor elements, which are elements adapted to generate a potential between two electrodes secured to opposed faces of the elements in response to mechanical deformation of the element, or may each comprise a strain gauge. A typical strain gauge comprises a metal or semi-conductor filament mounted on a backing sheet by means of which it can be attached to a body to be subjected to strain, so that the filament is correspondingly strained. The strain alters the electrical properties of the filament, such as, for example the resistance of the filament. This alteration forms a basis of measurement.

In either event, it will be appreciated, that the sensor elements 34 to 37 may generate, or may be utilised to generate, signals which are related to the deformation of the deformable part 15 of the load cell element 13 as illustrated in Figure 3.

It is to be appreciated that when the plate 14 is subjected to a twisting movement, such as the twisting movement in the clockwise direction imparted to the plate 14 upon forward movement of the frame 1 and the associated carriages 3 and 4, or a lateral outward motion, the deformable portion 15 of the load cell unit 13 will be twisted or deformed, with the twisting or deformation being concentrated on the narrowest portion, or the "waisted" region of the deformable portion 15 of the load cell unit. The sensors 34 to 37 are positioned

on a part of the deformable portion that will not be deformed as a consequence of this twisting or deformation of the waisted region of the deformable portion 15 of the load cell element. Thus, if the plate 14 is subjected to a twisting movement or a lateral movement, the sensors 34 to 37 will not provide an output.

It is also to be appreciated that when the frame 1 and the associated carriages 3 and 4 are in their forward-most position, a substantial downward force will be applied to the plate 14. The plate 14 is kept horizontal, and the plate 16 is kept in a horizontal condition. The resultant forces tend to cause the deformable portion 15 to deform in such a manner that, viewed from the side, the deformable element is bent or curved in the region of each of the pairs of sensors, but is substantially linear across the "waisted" region of the deformable portion 15. The sensors are positioned to respond to this deformation.

Referring now to Figure 4, the load cell element 21 provided at the rear of the rail 6 is illustrated. The load cell element 21 comprises a plate 22 having apertures 40,41, formed therein, by means of which the load cell may be connected to the shoe 19 and the rail 6. The deformable portion 23 of the load cell element is of the same design as the deformable portion 15 of the load cell element 13 as described above. Thus the deformable portion 23 is of generally rectangular form, and has two arcuate side walls 42,43 of concave form, thus providing a central narrow or "waisted" region for the deformable portion 23 of the load cell element. Two pairs of sensors 46,47 are mounted in position on opposed sides of the narrowest region, and again the sensors may be piezo electric sensors or may be strain gauges. The deformable portion 23 of the load cell element 21 is connected to the mounting plate 24 which is provided with an

aperture 48 adapted to receive a bolt by means of which the plate 24 may be connected to the mounting lug 25.

It will be appreciated that the deformable portion 23 of the load cell element 21 will deform in a manner corresponding to that of the deformable portion 15 of the load cell element 13 described above.

Thus each load cell element will provide an output when subjected to a downward force, but will not provide an output when subjected to a twisting force.

Figure 5 illustrates a blank which may be utilised to form a slightly modified form of load cell element corresponding to the load cell element 21. The blank is provided with regions defining the plates 22 and 24, and a deformable portion 23. The deformable portion 23 is formed by two substantially "V"-shaped recesses 50,51 formed on opposed sides of the deformable region. Each recess 50,51 has inwardly converging linear sides 52,53 which merge in a curved region 54, thus providing a narrow "waist" 55. The sensor elements 44,45,46,47 are mounted in position in pairs on opposite sides of the "waist".

In Figure 5 the recesses 50,51 are relatively "wide" with the angle between the linear sides 52,53 of each recess being approximately 80°.

Figure 6 illustrates a modified embodiment of the invention, which is similar to the embodiment of Figure 5, but in which the angle between the linear walls of the "V"-shaped recess on each side of each deformable portion 23 is of the order of 40°.

Figure 7 illustrates a further modified embodiment of the invention in which the "V"-shaped recesses described above are replaced by "U"-shaped slits 60,61, formed in opposed sides of the deformable region 23 of the load cell unit. The slits 60,61 are of the same configuration, and each have parallel opposed side walls 62,63 inter-connected by a curved region 64 forming the basis of the slit. A very narrow waist 65 is thus formed in the centre of the deformable region 23 of the load cell unit. The figures all show the preferred locations for the sensors, provided in pairs on each side of the narrowest part of the deformable portion of the sensor unit.

CLAIMS:

1. A sensor arrangement incorporated with a vehicle seat for sensing the position of the occupant of the vehicle seat, wherein the vehicle seat is provided with two carriages, each carriage being mounted for axial movement along a respective elongate rail to permit adjustment of the position of the seat, the rails being mounted in a motor vehicle in a substantially horizontal position, the rails converging so that the distance between the rails, at one end thereof, is less than the distance between the rails at the other end thereof, each end of each rail being mounted to a fixed part of the motor vehicle by means of a respective unit, each unit being adapted to generate a signal responsive to the downward force applied to the unit wherein each unit comprises a first region connected to the respective rail, and a second region connected to a fixed point on the motor vehicle, and an intermediate deformable region, the deformable region being of a "waisted" configuration and having one or more sensor elements thereon adapted to provide an output signal in response to deformation thereof.

2. An arrangement according to Claim 1 wherein the deformable region is provided with two pairs of sensor elements thereon, each pair of sensor elements being located on a respective side of the narrowest part of the waisted deformable region.

3. An arrangement according to Claim 1 or 2 wherein each sensor is a piezo electric sensor.

4. An arrangement according to Claim 1 or 2 wherein each sensor is a strain gauge.

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5. An arrangement according to any one of the preceding Claims wherein the deformable region has two opposed concave arcuate side edges to provide the waisted configuration.

6. An arrangement according to any one of Claims 1 to 4 wherein the deformable region has two inwardly directed substantially "V"-shaped recesses to provide said waisted configuration.

7. An arrangement according to Claim 6 wherein the angle between the opposed sides of each "V"-recess is substantially 80°.

8. An arrangement according to Claim 6 wherein the angle between the opposed sides of each "V" recess is approximately 40°.

9. An arrangement according to any one of Claims 1 to 4 wherein the deformable region is provided with opposed inwardly directed parallel-sided slots to provide said waisted configuration.

10. A sensor unit, said unit comprising a first portion by means of which the unit may be connected to one element, and a second portion by means of which the unit may be connected to a second element, and an intermediate deformable region, the deformable region being of a "waisted" configuration, and carrying at least one sensor element responsive to deformation of the deformable region.

11. A sensor unit according to Claim 10 wherein the deformable region is provided with two pairs of sensor elements thereon, each pair of sensor

elements being located on a respective side of the narrowest part of the waisted deformable region.

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12. A sensor unit according to Claim 10 or 11 wherein the or each sensor is a piezo electric sensor.

13. A sensor unit according to Claim 10 or 11 wherein the or each sensor is a strain gauge.

14. A sensor unit according to any one of Claims 10 to 13 wherein the deformable region has two opposed concave arcuate side edges to provide the waisted configuration.

15. A sensor unit according to any one of Claims 10 to 13 wherein the deformable region has two inwardly directed substantially "V"-shaped recesses to provide said waisted configuration.

16. An arrangement according to Claim 15 wherein the angle between the opposed sides of each "V" recess is substantially 80°.

17. An arrangement according to Claim 15 wherein the angle between the opposed sides of each "V" recess is approximately 40°.

18. An arrangement according to any one of Claims 10 to 13 wherein the deformable region is provided with opposed inwardly directed parallel-sided slots to provide said waisted configuration.

19. A sensor arrangement incorporated with a vehicle seat substantially as herein described with reference to and as shown in the accompanying drawings.

290 A sensor unit substantially as herein described with reference to and as shown in the accompanying drawings.

21 Any novel feature or combination of features disclosed herein.